ORIGINAL ARTICLE

Pancreatectomy with vein reconstruction: technique matters

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Abstract

Background: A variety of techniques have been described for portal vein (PV) and/or superior mesenteric vein (SMV) resection/reconstruction during a pancreatectomy. The ideal strategy remains unclear.

Methods: Patients who underwent PV/SMV resection/reconstruction during a pancreatectomy from 2005 to 2014 were identified. Medical records and imaging were retrospectively reviewed for operative details and outcomes, with particular emphasis on patency.

Results: Ninety patients underwent vein resection/reconstruction with one of five techniques: (i) longitudinal venorrhaphy (LV, $n = 17$); (ii) transverse venorrhaphy (TV, $n = 9$); (iii) primary end-to-end ($n = 28$); (iv) patch venoplasty (PV, $n = 17$); and (v) interposition graft (IG, $n = 19$). With a median follow-up of 316 days, thrombosis was observed in 16/90 (18%). The rate of thrombosis varied according to technique. All patients with primary end-to-end or TV remained patent. LV, PV and IG were all associated with significant rates of thrombosis ($P = 0.001$ versus no thrombosis). Comparing thrombosed to patent, there were no differences with respect to pancreatectomy type, pre-operative knowledge of vein involvement and neoadjuvant therapy. Prophylactic aspirin was used in 69% of the total cohort (66% of patent, 81% of thrombosed) and showed no protective benefit.

Conclusions: Primary end-to-end and TV have superior patency than the alternatives after PV/SMV resection and should be the preferred techniques for short (<3 cm) reconstructions.

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Introduction

A pancreatectomy with venous reconstruction is increasingly being performed to offer the benefits of surgical resection to patients with locally advanced disease. Several single-centre reports have established that a pancreaticoduodenectomy with venous resection/reconstruction can be performed with comparable morbidity, mortality and long-term survival to those with standard resections.[1–3] The 2009 expert consensus statement advocated for a pancreaticoduodenectomy with vein resection/reconstruction as a recommended standard of practice for pancreatic adenocarcinomas locally invading the portal vein (PV)/ superior mesenteric vein (SMV) or the superior mesenteric-portal vein (SM-PV) confluence in institutions experienced and capable of doing these technical operations.[4]

This study was presented at the Annual Meeting of the AHPBA, 11–15 March 2015, Miami, Florida.

The role of surgery with vascular reconstruction in pancreatic neuroendocrine (pNET) tumours is somewhat less defined than pancreatic adenocarcinoma; however, the retrospective data available supports an aggressive approach to surgical resection in carefully selected patients.[5,6]

At present, venous resection/reconstruction during a pancreaticoduodenectomy is performed in up to 20-25% of patients in some centres.[1] Despite being increasingly common, a vascular resection during pancreatic surgery is non-standardized. Although a variety of techniques have been described,[7–9] the ideal strategy remains unclear. Outside of the basic tenants to create a tension-free anastomosis and optimize size match when interposition grafting is used, there is little in the literature relating the technical aspects and outcomes specific to each procedure. In addition, there is significant heterogeneity in the use of anticoagulation/antiplatelet therapy after PV/SMV reconstruction; use is at the discretion of the surgeon with no published guidelines that exist for the type or duration of

anticoagulation/antiplatelet after venous reconstruction.[10] The aim of this study was to define the rate and predictors of thrombosis after a pancreatectomy and concomitant venous resection/reconstruction, with particular attention to the influences of operative technique and post-operative pharmacological management.

Patients and methods
Patients
Patients who underwent any pancreatic resection for any pathology where a resection and reconstruction of the porto-mesenteric venous system was performed from 2005 to 2014 were identified through a prospectively maintained database. Surgical resection types included a Whipple pancreaticoduodenectomy, total pancreatectomy and subtotal pancreatectomy. Venous reconstruction was performed by one of three surgeons (one hepato-pancreato-biliary and two vascular) surgeons. Specific patient data were retrospectively collected using the hospital electronic medical record after Institutional Review Board approval was obtained. Data abstracted included demographics, neoadjuvant and treatment history, intra-operative variables, type of vascular reconstruction, and pathological staging. Post-operative imaging studies were reviewed to determine patency or occlusion of the venous reconstruction. All patients underwent radiographic surveillance follow-up at 1, 3, then at 3-month intervals with computed tomography (CT) or magnetic resonance imaging (MRI). Those patients that underwent venous reconstruction by a vascular surgeon had several other follow-up appointments and additional imaging by vascular ultrasound. Acute thrombosis was defined as occlusion of the portal venous system confirmed by imaging within 30 days of the operation; late thrombosis was defined as lack of patency on follow-up imaging after 30 days from surgery.

Operative technique
Patients with CT evidence of tumour vessel abutment or occlusion at the PV, SMV or SM-PV confluence had the right neck or one upper thigh prepped and draped for access to the right internal jugular or the superficial femoral vein according to surgeon preference. The right internal jugular vein takes a more superficial course in the neck and has a larger diameter than the left internal jugular vein.[11] Venous reconstruction was categorized into one of five techniques. Those without use of a conduit include (i) longitudinal venorrhaphy (LV – either by using a Satinsky clamp with a longitudinal closure of the vein, Fig. 1a–b or by performing a sleeve resection of the vein with a TA30 stapler pulled close to the tumour, Fig. 1c–d), (ii) transverse venorrhaphy (TV) where a longitudinal ellipse of the vein is excised; however, a transverse closure of the vein is performed (Fig. 1e–f), and (iii) segmental resection of the vein (with or without splenic vein preservation) and primary end-to-end closure (primary) using a running 6-0 Prolene suture (Fig. 2a–b). Venous reconstruction that included use of a con-

duit was performed by (iv) patch venoplasty (patch) with a native vein harvested from another location, a cryopreserved vein or Bovine pericardium used to fill a tangential resection of the vein (Fig. 3a) and (v) segmental resection of the vein and interposition graft (IG) reconstruction through a number of native conduits, primarily including the internal jugular vein, renal vein, saphenous vein and superficial femoral vein (Fig. 3b–c). Splenic vein resection was not performed routinely; the vein was divided when tumour invasion involved this confluence, additional venous length was needed to perform primary end-to-end closure, or to facilitate exposure to the proximal superior mesenteric artery (SMA) if required. Prior to venous reconstruction, in most cases, the arterial dissection was completed first so that the specimen was left attached only at the site of vein encasement or abutment. In those instances where chronic venous occlusion had resulted in numerous varices, early decompression was accomplished by creating a mesocaval shunt or early venous reconstruction with internal jugular grafting prior to pancreatic dissection. Systemic heparinization was not routinely used for venous reconstruction.

Statistical analysis
Discrete categorical variables were compared using the chi-square test or Fisher's exact test, where applicable. Continuous variables were expressed as median with an interquartile range (IQR) and means were compared using the Mann–Whitney U-test. Kaplan–Meier estimations were used to analyse venous patency from the time of surgery. All tests were two-tailed, and statistical significance was set at a P-value < 0.05. Statistical analyses performed using STATA version 13.1 (StataCorp, College Station, TX, USA).

Results
Venous reconstruction
A pancreatectomy requiring venous reconstruction was performed in 90 patients during the study period out of 665 total pancreatectomies. Patient characteristics of the cohort, stratified by the occurrence of thrombosis, are shown in Table 1. Operative and post-operative characteristics are shown in Table 2. In patients in which a Patch or IG reconstruction was performed, an autologous conduit or patch was used in 24 (27%) reconstructions (2 gonadal, 4 internal jugular, 2 renal, 6 saphenous and 10 superficial femoral veins) and a preserved conduit or patch such as cryovein ($n = 2$) or bovine pericardium ($n = 10$) was used in 12 (13%). There was one perioperative death within 30-days (1%) in a patient from the thrombosed group who underwent a Whipple for pancreatic adenocarcinoma. The patient suffered a post-operative bile leak and an episode of intraabdominal bleeding requiring transfusion on post-operative day 11; however, no etiology of the bleed was found on CT angiogram. The scan demonstrated new splenic and SMV/PV thrombosis as it entered the